RADIO CHANNEL ACCESS CONTROL

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is related to U.S. patent application Ser. Nos. 07/909,487, filed on Jul. 6 of 1992, now U.S. Pat. No. 5,268,694; 07/795,610, filed on Nov. 21, 1991, now U.S. Pat. No. 5,293,576; and 08/031,586, entitled "COMMUNICATION SYSTEM EMPLOYING SPECTRUM REUSE ON A SPHERICAL SURFACE" and filed on Mar. 15 of 1993 now U.S. Pat. No. 5,367,304, which are assigned to the same assignee as the present application.

1. Technical Field of the Invention

The present invention relates generally to communication systems. More specifically, the present invention relates to systems that divide an area within which communications are to take place into cells and which allocates limited spectral resources among the various users in the cells.

2. Background of the Invention

Conventional cellular communication systems, adopt a method for subscribers to access the communication system. Generally speaking, system antennas are erected at spaced apart locations. Each system antenna, along with transmitter power, receiver sensitivity, and geographical features, defines a cell location and size. A cell is a geographical area on the surface of the earth within which communications may take place via a subscriber unit having predetermined operating characteristics and via the cell's antenna. In a cellular system that efficiently uses the spectrum allocated to it, system antennas are located to minimize overlap between their respective cells and to reduce gaps between the cells.

The spectrum allocated to a conventional cellular system is divided into a few discrete portions, typically frequency bands (also referred to as "channels"). Each cell is allocated one or more of the discrete portions of the spectrum, and each cell is preferably surrounded by cells that use other discrete portions of the spectrum. Communications within a cell use only the discrete portion of the spectrum allocated to the cell, and interference between communications taking place in other nearby cells is minimized because communications in such nearby cells use different portions of the Spectrum. Co-channel cells are cells that reuse the same discrete portion of spectrum. To minimize interference, the frequency reuse plan spaces co-channel cells a predetermined distance apart.

In conventional cellular communication systems, subscriber units acquire a radio channel by randomly selecting one of several acquisition channels provided by the system in a specific area of coverage, for example, a cell. To gain access to the communication system, the subscriber unit initiates a protocol with the system in an acquisition channel. Examples of protocols include ALOHA-type protocols well known in the art. The subscriber unit receives as part of the protocol, an assignment of a specific channel called the traffic channel on which to communicate.

ALOHA schemes typically comprise four modes: 1) Transmission Mode where users transmit an acquisition request message to the system; 2) Listening Mode where after transmitting the acquisition request message, the user listens for an acquisition acknowledgment (ACK) or a negative acknowledgment (NAK) from the communication system; 3) Re-transmission Mode where the acquisition request message is re-transmitted to the system when a NAK has been received; and 4) Timeout Mode, the user re-transmitts the acquisition request message when the user does not receive a ACK or NAK within a specified period of time. Problems occur with ALOHA protocol schemes when transmissions from various users overlap in time (i.e. collide) causing reception errors. This phenomena is known as "thrashing".

One of the major problems with ALOHA schemes is the collision of transmissions from users simultaneously attempting to access a communication system. Examples of ALOHA protocols that reduce reception errors include slotted ALOHA (S-ALOHA) and reservation ALOHA (R-ALOHA). In a S-ALOHA protocol, a sequence of synchronization pulses are broadcast to all stations, and as with most ALOHA schemes, packet lengths are constant. Users are required to transmit messages in the time slot between synchronization pulses, and can be started only at the beginning of a time slot. S-ALOHA reduces the amount of collisions between users requesting access since only messages transmitted in the same time slot can interfere with one another.

R-ALOHA protocol schemes employ two basic modes: an unreserved mode and a reserved mode. In the unreserved mode, a time frame is established and divided into a number of small reservation sub-slots. Users use these small sub-slots to reserve message slots. After requesting a reservation, the user listens for an acknowledgment and slot assignment. In the reserved mode, a time frame is divided into M+1 slots whenever a reservation is made. The first M slots are used for message transmissions, while the last slot is subdivided into sub-slots to be used for reservation requests. Users send message packets only in their assigned portions of the M slots.

A system with multiple users having random access typically uses a controller to impose order. The controller periodically polls the user population to determine their service requests. If the user population is large (i.e. in the thousands) and the traffic is bursty, the time required to poll can be excessive. Techniques for polling including "Binary Tree Search" and "Straight Polling" are well known in the art.

With both S-ALOHA and R-ALOHA in a system with many users and under cases of heavy loading, there may be significant interference between subscriber units on the acquisition channel. As a result, relatively few subscriber units may actually complete the protocol and receive assignment of an acquisition channel. Further, it is possible that even while a subscriber unit may succeed in completing an acquisition protocol, no traffic channels are available for assignment. This is a waste of resources by the subscriber unit and the communication system. In a satellite based communication system, this problem is more serious because of the need to conserve limited spacecraft resources, such as for example, satellite battery energy.

What is needed is a means and method that reduces collisions between users transmitting on an acquisition channel. Further, what is needed is a means and method to prevent assignment of an acquisition channel to a subscriber unit when no traffic channels are available. What is also needed is a means and method to allow a subscriber unit to determine when service is not available without excess transmissions, and to limit acquisition to the communication system to restricted classes or sets of classes when service capacity is limited.

Thus, there continues to be a need for an improved communication system to support multiple users and to minimize the number of unsuccessful acquisition attempts.

SUMMARY OF THE INVENTION

An advantage of the present invention is to provide a method of controlling access of subscriber units to a com-